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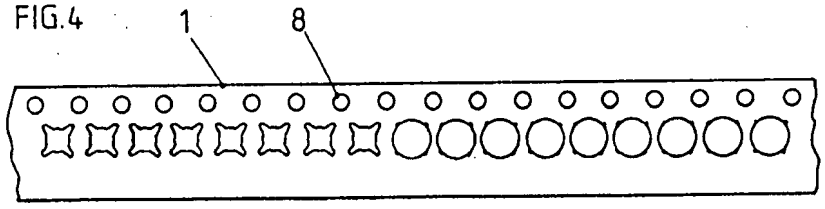
(54) **Fastener carrier tape.**

(57) A fastener carrier tape (1), for fasteners (4), such as rivets, with a shank (15) and relatively enlarged head (16), incorporates successive fastener retention apertures (5) with supplemental peripheral weakening slits or cut-outs (6), to promote controlled tape deformation and failure and thus controlled discharge of the fastener head through the tape and retain fastener orientation; and supplementary tape indexing apertures (8) corresponding to the fastener retention apertures for fastener positioning.

FIG.4



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Technical Field

This invention relates to fastener carrier tape and particularly, but not exclusively, the discharge of fasteners from such a carrier tape into a delivery chamber or tube of an application machine which will apply them to work-pieces, typically using a fastener driving plunger which discharges a fastener from the tape and continues to drive the fastener through the delivery tube.

Such a delivery chamber allows fastener application where workpiece access is restricted.

As fasteners are released from the carrier tape, they need to be guided precisely into a delivery chamber, otherwise they may lose their orientation.

The term fastener is employed herein to embrace a disparate variety of elements for joining one component to another.

However, the invention is of particular relevance to rivets, such as hollow part tubular self-piercing rivets, with a shank and relatively enlarged head.

Fasteners, such as rivets, whose length is short in comparison with girth present special feeding control problems because of their inherent tendency to tumble.

Background Art - fastener retention.

In current practice, the shank of the fastener is fed or loaded, as a tight or snug fit, into a pre-pierced retention hole of complementary profile in the tape and at the point of application the head of the fastener is forced through the hole.

Forcing the head of the fastener through a closely-inter-fitting tape retention hole - ie one in close conformity with the fastener shank diameter - subjects the tape to considerable deformation - leading to stretching and often splitting.

The consequent tape fragments may impede the feeding of the fastener into the mouth of a delivery tube, or may disturb the fastener orientation upon discharge from the tape.

As the pattern of tape deformation is variable and unpredictable, there is a danger that tape material will be trapped between the head of the fastener and the walls of a delivery chamber, as the fastener enters the chamber.

In order to overcome this, the diameter of the mouth of the chamber has to be increased to an extent that the mouth section can no longer be fully effective in guiding the fastener into the chamber.

Background Art - tape positioning.

Diverse mechanisms have been developed for the purpose of bringing each fastener in turn into the delivery chamber, but these generally have the disadvantage of applying the forces required directly onto the fastener concerned, or onto one adjacent to it.

In so doing, they frequently cause the fasteners to tilt within the tape - and in turn this leads to feeding problems, particularly when the fastener length is small relative to its diameter.

Many such earlier proposals rely upon a remote pushing action (i.e. they apply a pushing action to a fastener one or two removed from the one being positioned for fastening); others use a pulling action wherein they pull the tape until a fastener comes up against a physical stop.

In each case the fastener is subjected to a de-stabilising force.

Disclosure of Invention - fastener retention holes.

It has been found preferable to weaken the tape at local points around the circumference of the fastener retention hole, in order to promote a predetermined mode of deformation of the tape as the head of the fastener passes through it.

For instance, the tape can be weakened by completely or partially cutting or shearing it at selected local points around the circumference - thereby pre-determining the manner of tape deformation and splitting, as the head of the fastener passes through it.

More particularly, by incorporating such split-lines:

firstly, the displacement force required (eg of a driving plunger) to push the fastener (head) through the tape - and consequently the extent of local tape stretch or deformation can be reduced; and

secondly, lines of failure can be more precisely proscribed.

For instance, if the tape material is partially cut or sheared in four lines radiating out, quadrantally at 90° to each other, from the fastener retaining holes, it can be ensured that the tape will split along these lines, as the head of the fastener passes through the tape.

In so doing, four depending flaps of material are generated - which can fit closely into specially shaped recesses within the mouth of the delivery chamber.

It has been found in practice that a satisfactory manner of local tape weakening is to cut-out or remove material altogether - as opposed to merely making slit cuts or cut lines which penetrate some or all of the material thickness.

In particular, by introducing circumferentially-spaced, radial-extending cut outs or slots around a fastener retention hole periphery, the tape behaviour upon fastener discharge is more readily and consistently controlled.

Such slots can very conveniently be formed integrally with each retention hole profile, by means of a simple punch and die - and the geometry of the star-shaped overall retention hole so formed can be very consistently controlled in manufacture.

One of the main advantages of slots is that, by

forming them with a smooth radius at their outward ends, it is possible to avoid the local stress concentrations which can lead to splitting of the tape as the head of the fastener passes through.

Maintaining control of the slot geometry provides a means of control of the geometry of the material flaps between the slots - and of thereby ensuring that, as these flaps flex to allow the head of the fastener to pass through the tape, they collectively provide a guidance funnel.

By providing a controlled mode of deformation of the tape, control of the positioning of the fastener as it passes through the tape can be preserved - without undue risk of the tape becoming trapped between the head of the fastener and a delivery chamber mouth.

Both the cut slit and cut-out slot means of locally weakening the tape are particularly beneficial when used in conjunction with a tubular delivery chamber also devised by the Applicants - the subject of separate application for patent protection - and which deploys an internal guide to form a constriction movable co-operatively in conjunction with fastener movement through the tube.

The depending tape flaps formed upon fastener discharge may co-operate with such a delivery tube internal guide.

Profiled fastener retention hole cut-outs can also be used in conjunction with tape indexing or positioning slots as described elsewhere herein.

Disclosure of Invention - tape position indexing holes.

It has been found preferable to apply all indexing and positioning forces directly to the tape - so that the fastener can be carried into its correct location, without any disturbing force being applied directly to it.

In accordance with another aspect of the present invention, positioning, or position indexing, slots (or positioning holes) are provided in the tape adjacent to the pierced holes into which the fasteners will be placed.

When carrier tape loaded with fasteners is fed to the application machine, the travel of the tape can, by the use of the positioning slots, be arrested by mechanical and/or optical means at the precise position required to position the next fastener centrally within the delivery chamber.

An advantage of using an optical system is that it can serve two purposes:
firstly, it can be used to signal that the tape has arrived at the correct position; and
secondly, it can be used to signal that an index has taken place - i.e. that there has been a period of time when the light signal has been interrupted by the tape.

It has been found that carrier tape and attendant fastener retention hole alignment can be achieved by positioning a light source on one side of the tape in line with the slots and a receiver on the other side of the tape - so that a light signal can be received when a slot either arrives at or departs from the light beam.

According to one aspect of the invention, there is provided a fastener carrier tape, for carrying a linear succession of discrete fasteners, each with a shank and relatively enlarged head, in a corresponding succession of fastener shank retention holes, each configured to provide the tape with a pre-determined mode of local deformation, upon passage of a fastener head there-through, in order to preserve a required fastener orientation until discharge from the tape.

According to another aspect of the invention there is provided a fastener carrier tape, for use in conjunction with a fastener application machine, including a fastener driving plunger, with a fastener contact driver head, and a delivery tube, for presenting a fastener to a remote workpiece, the driving plunger being operative to drive a fastener from the tape and through the delivery tube, until the fastener is driven into the workpiece thereby; the tape carrying a linear succession of discrete fasteners, each with a shank and relatively enlarged head, in a corresponding succession of fastener shank retention holes, each configured to provide the tape with a predetermined mode of local tape deformation, upon passage of a fastener head there-through, in order to preserve a required fastener orientation until a controlled discharge from the tape.

The retention hole profiles may incorporate supplementary peripheral cut-outs to create depending flaps upon local tape deformation, which flaps collectively form a fastener delivery or discharge guidance funnel, to co-operatively align and inter-nest with the mouth of a delivery tube, for presenting a fastener to a workpiece, and whereby fastener orientation is preserved until discharge from the tape, whereupon it is brought under the control of the delivery tube.

The individual fastener shank retention holes may comprise star-shaped cut-outs.

Alternatively, the fastener shank retention holes are configured with supplementary slits or cuts, partially or completely through the body of the tape material, to create depending flaps upon local tape deformation, which flaps collectively form a fastener delivery or discharge guidance funnel, to co-operatively align and inter-nest with the mouth of a delivery tube, for presenting a fastener to a workpiece, and whereby fastener orientation is preserved until discharge from the tape, whereupon it is brought under the control of the delivery tube.

The tape may incorporate a linear succession of position indexing and drive holes, one or more for each fastener location, and co-operatively disposed with respect to said fastener retention holes, whereby fasteners entrained in the tape may be brought precisely into alignment with a desired discharge posi-

tion, such as the mouth of a delivery tube for presenting fasteners to a workpiece.

The tape may be adapted to carry hollow, part tubular, self-piercing rivets.

Yet another aspect of the invention provides a fastener application machine utilising as a source of fastener supply, a fastener carrier tape as set out in the immediately preceding paragraphs. Such a machine may incorporate a tape position indexing mechanism and an optical beam tape alignment sensor for monitoring index hole position.

There now follows a description of some particular embodiments of the invention, by way of example only, with reference to the accompanying schematic and diagrammatic drawings, in which:

Figure 1 shows a plan view of a fastener carrier tape with a linear succession of fastener (shank) retention holes configured according to one aspect of the invention;

Figure 2 shows an enlarged view of an individual fastener retention hole of the carrier tape of Figure 1;

Figure 3 shows a side part-sectional view of a fastener about to be discharged from a carrier tape with a retention hole configured as in Figure 2;

Figure 4 shows the carrier tape of Figure 4 with additional tape position indexing holes;

Figure 5 shows a carrier tape with a double row of tape position indexing slots on opposite side edges, with an intervening row of fastener retention holes;

Figure 6 shows a carrier tape with position indexing slots utilised in conjunction with an optical alignment senor;

Figure 7 shows a side edge view of the tape indexing and optical alignment sensor Figure 13;

Figure 8 shows a carrier tape with position indexing holes utilised in conjunction with an optical alignment sensor; and

Figure 9 shows a side edge view of the tape indexing and optical alignment sensor of Figure 15.

Referring to Figure 1, a flexible carrier tape 1 incorporates a centrally-disposed row of fastener retention holes 5 in a linear succession.

The tape 1 is partially loaded with fasteners 4 with a shank 15 and relatively enlarged head 16, as depicted in Figure 3.

As shown in more detail in Figure 2, each fastener retention hole 5 is profiled as a generally circular central hole 2 with outwardly-tapered, radial slots or cut-outs 6, in a generally star-shaped array, to facilitate insertion and retention of a fastener 4.

An alternative retention hole configuration relies upon cut, split or shear lines partially or completely through the tape thickness. Indeed cuts or slits may replace or supplement cut-outs, ie wholesale local material removal.

It will be noted that the hole profile, whether cut-out slots, or slits, may extend marginally beyond the installed fastener head circumference.

Referring to Figure 3, a headed fastener 4 is depicted passing through flexible tape 1 into the funnel-shaped mouth 17 of a delivery tube 7 for directing fasteners to a remote workpiece, using an unshown driving plunger which displaces fasteners from the tape 1 and continues down the tube until the workpiece is contacted by the fastener, whereupon the fastener is driven into position.

As the fastener head 16 emerges through the deformed tape body, depending guidance flaps 19 are formed which co-operate as a funnel with the delivery tube mouth 17 - thereby preserving a desired fastener orientation until and upon tape discharge.

Referring to Figure 4, a carrier tape 1, similar to that of Figure 1, incorporates supplementary tape position indexing holes 8, to facilitate precise control of tape progress through a fastener application machine for which the tape forms a fastener supply.

Referring to Figure 5, a carrier tape otherwise of the kind shown in figure 1, has two rows of position indexing elongate slots 3a and 3b, disposed at the opposite tape side edges.

Referring to Figures 6 and 7, a carrier tape 40 has a central row of fastener retention holes 31 and a single row of corresponding position indexing slots 33 configured for optical alignment sensing.

More specifically, the indexing slots 33 are co-operatively disposed with respect to a pair of aligned light sources 34 mounted on one side of the carrier tape 40 and projecting parallel individual light beams 41 into light receivers or sensors 32 positioned on the opposite side of the tape.

The light sources 34 are positioned so that the light beams 41 pass through the extreme ends of individual positioning slots 33, so that the position of the slots 33 - and thus of the corresponding fastener retention holes 31 - can be precisely determined.

Referring to Figure 8, an alternative configuration of carrier tape relies upon two precisely spaced, pierced position indexing holes, in place of elongate slots.

Referring to Figure 9 shows the tape of Figure 15 used in conjunction with a pair of light sources and sensors such as in the arrangement of Figures 13 and 14.

Claims

I. A fastener carrier tape (1),
for carrying a linear succession of discrete fasteners (4),
each with a shank and relatively enlarged head,
in a corresponding succession of fastener shank retention holes (5),
each configured (6) to provide the tape with a pre-de-

termined mode of local deformation,
upon passage of a fastener head there-through,
in order to preserve a required fastener orientation
until discharge from the tape.

II. A fastener carrier tape (1),
for use in conjunction with a fastener application machine,
including a fastener driving plunger
with a fastener contact driver head,
and a delivery tube (7)
for presenting a fastener to a remote workpiece,
the driving plunger being operative to drive a fastener from the tape
and through the delivery tube,
until the fastener is driven into the workpiece thereby;
the tape carrying a linear succession of discrete fasteners,
each with a shank and relatively enlarged head,
in a corresponding succession of fastener shank retention holes (5),
each configured to provide the tape with a predetermined mode of local tape deformation,
upon passage of a fastener head there-through,
in order to preserve a required fastener orientation
until a controlled discharge from the tape.

III. A fastener carrier tape, as claimed in any of the preceding claims,
wherein the retention hole profiles incorporate supplementary peripheral cut-outs
to create depending flaps upon local tape deformation,
which flaps collectively form a fastener delivery or discharge guidance funnel,
to co-operatively align and inter-nest
with the mouth of a delivery tube,
for presenting a fastener to a workpiece,
and whereby fastener orientation is preserved until discharge from the tape,
whereupon it is brought under the control of the delivery tube.

IV. A fastener carrier tape, as claimed in any of the preceding claims,
in which the individual fastener shank retention holes comprise star-shaped cut-outs.

V. A fastener carrier tape, as claimed in any of the preceding claims,
wherein the fastener shank retention holes are configured with supplementary slits or cuts,
partially in or completely through the body of the tape material,
to create depending flaps upon local tape deformation,
which flaps collectively form a fastener delivery or discharge guidance funnel,
to co-operatively align and inter-nest
with the mouth of a delivery tube
for presenting a fastener to a workpiece,
and whereby fastener orientation is preserved until discharge from the tape,
whereupon it is brought under the control of the delivery tube.

VI. A fastener carrier tape, as claimed in any of the preceding claims,
incorporating a linear succession of index positioning and drive holes (8),
one or more for each fastener location,
and co-operatively disposed with respect to said fastener retention holes,
whereby fasteners entrained in the tape may be brought precisely into alignment with a desired discharge position,
such as the mouth of a delivery tube for presenting the fasteners to a workpiece.

VII. A fastener carrier tape, as claimed in any of the preceding claims,
adapted to carry hollow, part tubular, self-piercing rivets.

VIII. A fastener carrier tape, substantially as hereinbefore described,
with reference to, and as shown in, the accompanying drawings.

IX. A fastener application machine
utilising as a source of fastener supply,
a fastener carrier tape as claimed in any of the preceding claims.

X. A fastener application machine, as claimed in Claim 9 as appendant to Claim 6,
incorporating a tape indexing mechanism,
co-operatively disposed in relation to tape index holes.

XI. A fastener application machine, as claimed in Claim 10,
incorporating an optical beam sensor for monitoring tape index hole position.

FIG. 1

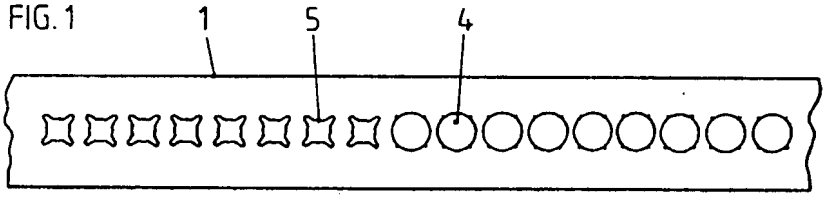

FIG. 2

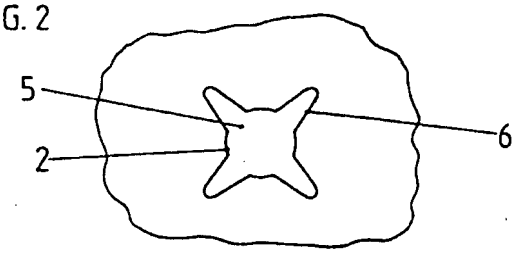

FIG.3

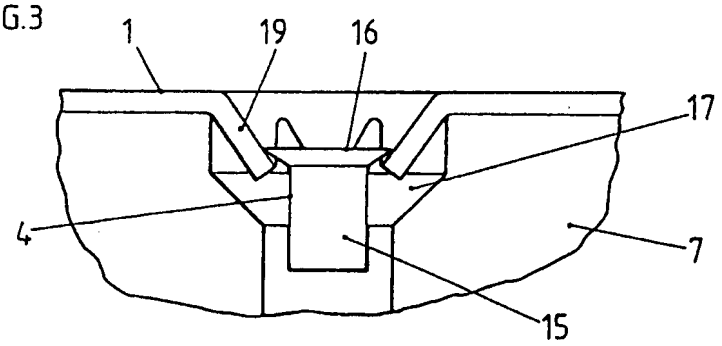

FIG.4

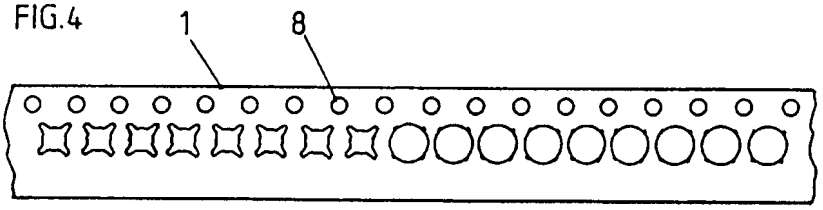

FIG.5

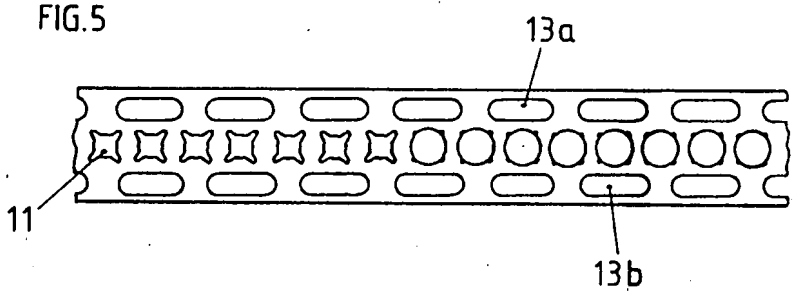

FIG. 6

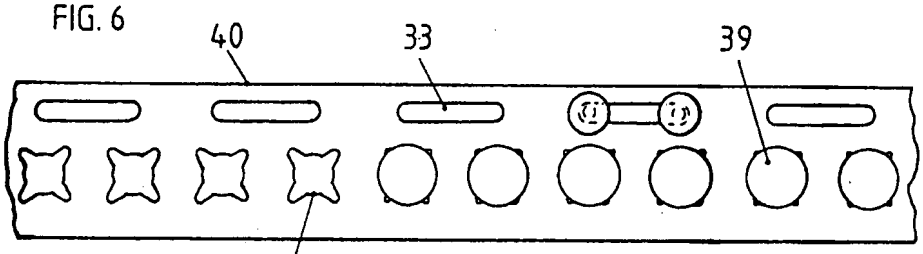

FIG. 7

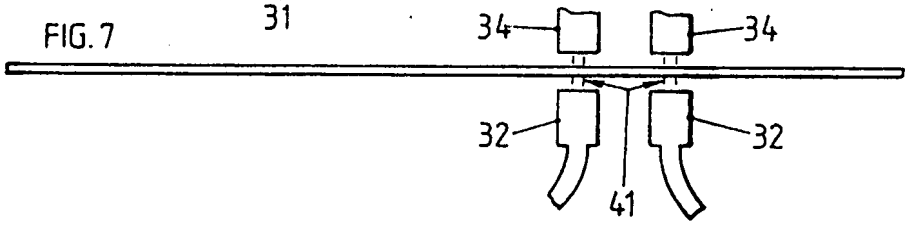

FIG. 8

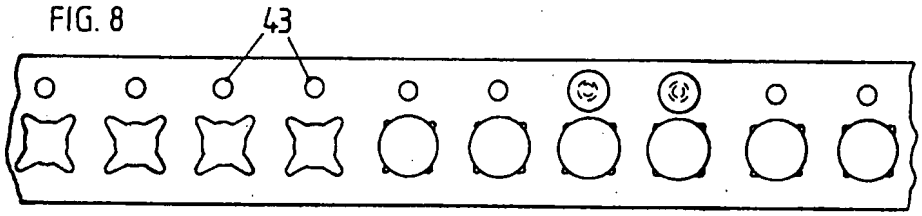

FIG.9